

ANGULAR MOMENTUM ALIGNED STATES IN TRANSITIONAL AND
DEFORMED NUCLEI

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1. In several transitional and deformed odd mass nuclei with an isolated large j -shell aligned states with $I=j, j+2, \dots$ are found, the spacing of which is close to that of neighbouring core states with $J=0, 2, 4, \dots |1|$. A uniform description starts from basis states

$$|IM, jJ\rangle = \sum \langle jmJ\nu | IM\rangle |jm\rangle |J\nu\rangle$$

with $|J\nu\rangle$ -vibrational like core states or

$$|IM, jJ\rangle = \sqrt{\frac{2I+1}{8\pi}} \sum (-)^{j-k} \langle Ikj-k | J0\rangle |jk\rangle D_{MK}^I$$

for rotor core states. Correspondingly particle-vibration or particle-deformed field interaction causes the mixing of basis states.

2. The simplest description, leading to $\Delta E_I = E_J - E_{I=J+j} = \text{const}$ for large j is the scalar phonon approximation $|2|$. For internal phonon lines in the vertex of the mass operator  geometry-dependending factors may be neglected for $j \gg 1$. As a result the states with $I=j$ are

$$|n, I=j, m, j\rangle = \alpha_{jm}^\dagger \frac{(B^\dagger - \alpha)^n}{\sqrt{n!}} \sum_{n'} \frac{\alpha^{n'}}{\sqrt{n'!}} |n'\rangle$$

B^\dagger - phonon creation operator, α - coupling constant; and the spectrum is equidistant

$$E_I = E_j - \hbar\omega\alpha^2 + n\hbar\omega$$

3. To account for geometry dependence, core states $|J\nu\rangle$ including anharmonicity or deformed rotor states are

required. For core states with negative spectroscopic quadrupole moments $Q_J < 0$ or prolate deformation $Q_0^O > 0$ one obtains aligned bands in the neighbouring odd nuclei. The main contribution to the nearly constant energy shift ΔE_I comes from the diagonal matrix element

$$\langle IM, jJ | H' | IM, jJ \rangle = -\kappa Q_0^O \langle r^2 \rangle \frac{l}{2l+3} \frac{J}{2J+3}$$

For $Q_J > 0$ ($Q_0^O < 0$) on the contrary a deformed band-like structure appears [3].

4. In the one-quasi-particle approximation the Pauli principle is accounted for by the factor $u_j^2 - v_j^2$ both in vibrational and deformed nuclei. This factor may lead to a weak coupling scheme even in deformed nuclei. Together with the sign of Q_J or respectively Q_0^O the factor $u_j^2 - v_j^2$ determines the scheme to be aligned or not.

REFERENCES

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